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**10/501377**

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**1 Claims**

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3 1. An electric motor monitoring system comprising an  
4 antenna, a data sampling means and a data processing  
5 means characterised in that the antenna provides  
6 means for detecting a radio-frequency signal  
7 generated by arcing events from a brush contact of  
8 the electric motor, and provides a diagnostic for  
9 monitoring the operation of both mechanical and  
10 electrical components of the electric motor.

11

12 2. An electric motor monitoring system as claimed in  
13 Claim 1 wherein the antenna comprises a means for  
14 screening background noise so improving the overall  
15 signal to noise ratio of the electric motor  
16 monitoring system.

17

18 3. An electric motor monitoring system as claimed in  
19 Claim 1 or Claim 2 wherein the antenna further  
20 comprises a frequency matching unit such that the  
21 frequency matching unit allows the antenna to be  
22 frequency tuned so as to optimise its operation with  
23 the electric motor.

24

25 4. An electric motor monitoring system as claimed in  
26 Claim 4 wherein the frequency matching unit  
27 comprises a signal conditioning unit.

28

29 5. An electric motor monitoring system as claimed in  
30 any of the preceding Claims wherein the antenna  
31 comprises a balanced Faraday screened loop antenna.

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- 1 6. An electric motor monitoring system as claimed in  
2 claim 1 to 4 wherein the antenna comprises an  
3 unbalanced Faraday screened loop antenna.  
4
- 5 7. An electric motor monitoring system as claimed in  
6 any of the preceding Claims wherein the antenna  
7 comprises an electric field probe or a magnetic  
8 field probe.  
9
- 10 8. An electric motor monitoring system as claimed in  
11 any of the preceding Claims wherein the data  
12 sampling means comprises an anti aliasing filter, an  
13 analogue to digital converter and a high speed PCI  
14 card such the data sampling means allows the high  
15 frequency signal, over a predetermined length of  
16 time, to be captured.  
17
- 18 9. An electric motor monitoring system as claimed in  
19 Claim 8 wherein the data processing means further  
20 comprises a computer processor capable of  
21 manipulating and storing the captured data.  
22
- 23 10. An antenna for measuring high frequency radio  
24 frequency signals associated with arcing events from  
25 a brush contact in an electric motor, the antenna  
26 comprising a loop and a loop screen, wherein the  
27 loop screen shields the loop from background noise  
28 thus improving the signal to noise ratio of the  
29 signal detected by the antenna.  
30
- 31 11. An antenna as claimed in Claim 10 wherein the loop  
32 screen physically covers all but a small detection  
33 section of the loop.

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2 12. An antenna as claimed in Claim 10 or Claim 11  
3 wherein the antenna further comprises a frequency  
4 matching unit such that the frequency matching unit  
5 allows the antenna to be frequency tuned so as to  
6 optimise the antenna's operation with the electric  
7 motor.

8

9 13. An antenna as claimed in Claim 12 wherein the  
10 frequency matching unit comprises a signal  
11 conditioning unit.

12

13 14. An antenna as claimed in any of Claims 10 to 13  
14 wherein the loop comprises a conductor and a  
15 screened coaxial cable such that the conductor is  
16 turned back on itself so as to form one or more  
17 turns while the end of the conductor cable is  
18 attached to the screen of the coaxial cable.

19

20 15. A diagnostic method for monitoring the operation of  
21 both mechanical and electrical components associated  
22 with an electric motor, the method comprising the  
23 steps of:

24 i) Detecting high frequency radio frequency  
25 signals associated with arcing events from a brush  
26 contact within the electric motor;  
27 ii) Sampling the high frequency signal over a  
28 predetermined length of time;  
29 iii) Processing the sampled data so as to provide  
30 information regarding the mechanical and electrical  
31 components of the electric motor.

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- 1 16. A diagnostic method according to Claim 15 wherein  
2 the method provides a means for associating the  
3 frequency of the high frequency signal to individual  
4 components of the electric motor.  
5
- 6 17. A diagnostic method according to Claim 15 or Claim  
7 16 wherein the detection of the high frequency  
8 signals employs a non-intrusive antenna.  
9
- 10 18. A diagnostic method according to any of Claims 15 to  
11 17 wherein the sampling provides a means for  
12 monitoring frequency modulation and amplitude  
13 modulation within the high frequency signals.  
14
- 15 19. A diagnostic method according to any of Claims 15 to  
16 18 wherein the processing of the sampled data  
17 comprises the application of Fast Fourier  
18 Transformations so as to convert the sampled data to  
19 interpretable frequency spectra.  
20
- 21 20. A diagnostic method according to any of Claims 15 to  
22 18 wherein the processing of the sampled data  
23 comprises the application of Digital Signal  
24 Processing techniques to the sampled data so as to  
25 convert the sampled data to interpretable frequency  
26 spectra.  
27
- 28 21. A diagnostic method according to Claim 20 wherein  
29 the Digital Signal Processing techniques comprise  
30 Wavelet Analysis.  
31  
32  
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- 1 22. A diagnostic method according to any of Claims 19 to  
2 21 wherein the interpretable frequency spectra  
3 comprise frequency features that can be directly  
4 associated with particular diagnostics of the  
5 mechanical or electrical components of the electric  
6 motor.  
7
- 8 23. A diagnostic method according to any of Claims 19 to  
9 22 wherein the interpretable frequency spectra  
10 comprise frequency features that can be directly  
11 associated with particular mechanical or electrical  
12 faults of the electric motor.  
13
- 14 24. A diagnostic method according to any of Claims 15 to  
15 18 wherein the processing of the sampled data  
16 comprises calculating an average width of the high  
17 frequency signals, above a predetermined level, over  
18 a number of arcing events.  
19
- 20 25. A diagnostic method according to any of Claims 15 to  
21 18 wherein the processing of the sampled data  
22 comprises calculating an average height of the high  
23 frequency signals over a number of arcing events.  
24
- 25 26. A diagnostic method according to any of Claims 15 to  
26 18 wherein the processing of the sampled data  
27 comprises calculating an average ratio of the width  
28 and height of the high frequency signals over a  
29 number of arcing events.  
30
- 31 27. A diagnostic method according to any of Claims 15 to  
32 26 wherein the method comprises a step of self-  
33 calibration of the diagnostic method.

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2 28. A diagnostic method according to Claim 27 wherein

3 the self-calibration of the diagnostic method

4 comprises a current measuring technique including

5 the sub-steps of:

6 i) Measuring the torque on the electric motor by

7 employing the non-intrusive antenna;

8 ii) Measuring directly the current in the electric

9 motor so as to enable the torque on the electric

10 motor to be calculated;

11 iii) Taking the difference between the two methods

12 for obtaining the value of the torque on the

13 electric motor so providing a compensation factor;

14 and

15 iv) Adding the compensation factor to the non-

16 intrusive antenna method for measuring the torque on

17 the electric motor.

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